	Wisconsin[1]	Minnesota[2]	New York[3]	Ohio[4]	Washington[5,6]
Basis	Numerical Values called sediment quality guidelines (SQGs) Based on MacDonald et al. (2000)[7] for most. Also CCME (1999)[8], Ontario Guidelines (Persaud, et al., 1993)[9] and NOAA (Long and Morgan 1991)[10] Benthic Effects based. Not for bioaccumulation or food chain. 3 values for each chemical: TEC, MEC and PEC	Numerical Values called sediment quality targets (SQTs) Based on MacDonald et al. (2000) for most. Also CCME (1999), and NYSDEC (1999)[11]. Benthic Effects based. Not for bioaccumulation or food chain. 2 values for each chemical: Level I SQT = TEC Level II SQT = PEC	Numerical Values called sediment guidance values (SGVs) Effects based and bioaccumulation based SGVs. For nonpolar organic contaminants, use the EPA equilibrium portioning procedures For metals, adopted MacDonald et al. (2000) TEC and PEC Values For total PCBs, NYDEC has their own SGVs	Numerical Values Recommends MacDonald et al. (2000), U.S. EPA Region V Ecological Screening Levels[12], Ohio EPA Sediment Reference Values[13] or U.S. EPA Region IX values for residential soil (for human health)[14]. Benthic effects and/or human health considered, depending on the potential exposure. After screening, for data that exceeds the SQGs, Ohio uses EPA procedures for equilibrium partitioning benchmarks. Not for bioaccumulation.	Numerical and narrative sediment standards. The only state with promulgated standards. Calculated sediment quality values (SQVs) from large datasets in Washington, Oregon and Idaho Updated in 2010 to reflect information from a larger geographic area. Large data analysis effort. Over 600 stations with combinations of bulk chemistry and bioassays used to develop. Effects based SQVs for benthic organisms.
Chemicals included	18 PAH, 12 metals, total PCB, pesticides and other compounds (see excel table for full listing).	13 PAH, 8 metals, total PAH, total PCB and 10 pesticides	SGVs for 9 metals and 61 organic compounds including total PAH, total PCB, pesticides, etc.	Does not list chemicals specifically for screening, but rather refers back to the available SQGs listed above. ESBs evaluated for 34 PAHs and metals.	SQVs for 10 metals, 21 organic chemicals, including total PAH, total PCBs, pesticides, etc. 2 SQVs for bulk petroleum hydrocarbons. Also includes ammonia and total sulfides.
How Used?	Part of tiered assessment framework Assess sediment quality for dredging projects Screening for benthic effects and bioavailability potential (ecological). Not for bioaccumulation or food chain	Designing monitoring programs Identify, rank and prioritize sediment associated contaminants Evaluate spatial patterns Ecological risk assessments	For screening, classification and assessment of sediments only to determine if sediments are having an effect on aquatic life. 3 classifications of sediments Class A: low risk (<TEC) Class B: slightly to moderately	Used for making sediment management decisions Three tiered process: 1. Screening to determine chemicals of concern 2. Evaluation of COCs for bioavailability using ESB	Setting standards for sediment quality (numeric and narrative) Apply standards to reduce pollutant discharges Provide a decision process for cleaning up contaminated

	Wisconsin[1]	Minnesota[2]	New York[3]	Ohio[4]	Washington[5,6]
	effects. Prioritize and rank sites and evaluate need to collect additional data Toxicity benchmarks for ecological risk assessments Weight of evidence decision making Not meant for stand-alone decision making, but could be used as remediation objective at sites where parties agree.	Screening tools for larger sites Level II SQT can be used as clean up values for small sites. For complex sites, use SQTs with other assessments (toxicity, benthic surveys, bioaccumulation tests). Guidance notes *the weight of evidence generated should be proportional to the weight of the decision in the management of contaminated sediment.*	contaminated (> TEC<PEC) Class C: high risk (PEC or greater) Not used for making decisions for sediment management, remediation, mitigation or disposal. Provide starting point for risk assessment Identification of COCs Weight of evidence approach, with additional lines of evidence used when predictions of toxicity from bulk chemistry and toxicity tests do not agree Other lines to use include benthic community, pore water, bioaccumulation testing, sediment contaminant aging, etc.	and AVS/SEM 3. HHRA if human health is a concern, or toxicity testing for aquatic life.	sediments Two effects levels, the sediment quality standard (SQS) and the clean-up screening level (CSL) SQS = no acute or chronic adverse effects level CSL = minor adverse effects level. The SQS is the long term goal for sediments CSL is the level above which clean-up sites are designated, and is the upper end of the range within which clean-up standards can be selected. Clean up goals fall between the SQS and CSL.
PAH Considerations	18 PAHs noted in guidance document. SQGs not available for 2 of the compounds, but noted their similarity to other compounds	13 PAHs in guidance document. Does not take into consideration toxic effects from UV exposure. In shallow environments, the SQTs could underrepresent the toxic effects.	For PAH mixtures, calculate ESB toxic units from 34 PAHs to evaluate effects to environment.	ESB procedures used for PAHs if found in screening step to be of concern.	Developed SQV only for total PAH
# in total	16 (different from MacDonald, which uses 13)	13. Guidance states to note if more than 13 used in total, indicate number.	Requires 16 for initial screening, 34 for higher level evaluation	34	19
TOC normalization?	Yes (for naturally occurring TOC). Where TOC not available, use bulk chemistry data.	No. Reviewed previous studies and found that dry weight concentrations predicted sediment toxicity as well or better than TOC normalized SQGs in field collected sediment. Notes that chemical binding to sediments is a complex and variable phenomenon that cannot be adequately represented simply by normalizing to TOC.	Yes, for the ESB TU calculations when evaluating PAH mixtures. In absence of TOC data, and to avoid additional data collection for TOC, NYDEC assumes a 2% TOC based on the statewide TOC average derived form 18 watersheds.	Yes (per ESB procedures)	No. Organic carbon normalization does not improve the reliability of the SQVs.

	Wisconsin[1]	Minnesota[2]	New York[3]	Ohio[4]	Washington[5,6]
Other Considerations	Noted potential for future use of EPA equilibrium partitioning approach for metals, PAH mixtures and other nonionic organic compounds for use as a screening tool.	For sediments with contaminant mixtures, MN uses mean PEC quotients (PEC-Q). Has procedures for calculating PEC-Q for mixtures containing total PAH, metals, and PCB.	NY guidance is very detailed with providing procedures modifying the EQP SGVs and for the metals SGVs to allow for site specific conditions.	2 alternatives to tier III evaluation: 1. Accept tier II evaluation and manage sediments according to results 2. Use pore water analysis to compare with state water quality standards.	Sediment biological criteria can also be used to set sediment clean up objectives. The SQS is set at the no adverse effects level including acute or chronic adverse effects. The CSL is set at the minor adverse effects level including acute or chronic adverse effects.

1. Wisconsin Department of Natural Resources. 2003. Consensus-based Sediment Quality Guidelines. Recommendations for Use & Application. Interim Guidance. Publ# WT-732 2003
2. Crane, J.L.. and S. Hennes. 2007. Guidance for the Use and Application of Sediment Quality Targets for the Protection of Sediment-Dwelling Organisms in Minnesota. Minnesota Pollution Control Agency document # tdr-gl-04.
3. New York State Department of Environmental Conservation (NYSDEC). 2014. Screening and Assessment of Contaminated Sediment.
4. Ohio Environmental Protection Agency. 2010. Guidance on Evaluating Sediment Contaminant Results.
5. State of Washington Department of Ecology. 2013. Sediment Management Standards. Chapter 173-204 WAC. Publication # 13-09-055.
6. State of Washington Department of Ecology. 2011. Development of Benthic SQVs for Freshwater Sediments in Washington, Oregon, and Idaho. Publication # 11-09-054.
7. MacDonald, D.D., C.G. Ingersoll, and T.A. Berger. 2000. Development and Evaluation of Consensus-based Sediment Quality Guidelines for Freshwater Ecosystems. Arch. Environ. Contam. Toxicol. 39:20-31.
8. Canadian Council of Ministers of the Environment (CCME). 1999. Canadian Sediment Quality Guidelines for the Protection of Aquatic Life: Summary tables. In: Canadian Environmnetal Quality Guidelines. 1999. Canadian Council of Ministers of the Environment, Winnipeg.
9. Persaud, D.R., R. Jaagumagi, and A. Hayton. 1993. Guidelines for the Protection and Management of Aquatic Sediments in Ontario. Standards Development Branch. Ontario Ministry of Environment and Energy. Toronto, Canada.
10. Long, E.R. and L.G. Morgan. 1991. The Potential for Biological Effects of Sediment-sorbed Contaminants Tested in the National Status and Trends Program. NOAA Technical Memorandum NOS OMA 52. National Oceanic and Atmospheric Administration. Seattle, Washington.
11. NYSDEC. 1999. Technical Guidance for Screening Contaminated Sediments, New York State Department of Environmental Conservation Division of Fish and Wildlife, Division of Marine Resources, Albany, NY.
12. U.S. EPA. 2003. Region V Ecological Screening Levels. August 22, 2003.
13. Ohio EPA. 2008. Sediment Reference Values. Division of Emergency and Remedial Response. Pg. 3-32. April 2008.
14. U.S. EPA. 20008. Preliminary Remediation Goals for Soil. Region 9. May 2008.

Draft - Sediment Evaluation Process

(September 19, 2016 Verison)

Initial Sediment Evaluation Criteria
Contaminant
Type (bio-accumulator, PCBs, PAHS, metals)
Concentration
Background concentration (known or unknown)
Source (known or unknown; potential for recontamination)
Project Type
Define degree and extent (e.g. NR 700, known source/responsible party)
Deal with project area only (e.g. NR 347, DOT, emergency cleanup, unknown source/responsible party)
Waterway/Waterbody Use (Past, Present & Future)
Urban
- Industrial
- Non-industrial (Commercial)
- Areas with active continuous discharge
Rural
- Agricultural
- Recreational (Fishery)
Environment
Geology
Sediment type (soft, semi-consolidated, till, benthic zone)
Deposition or transient
Sensitivity (exceptional waterway, wetland)
Exposure Pathways/Receptors
Human
Ecological
Both

OHWM determination needed?

Criteria being developed by Subgroup 3.

≤ Default Numbers and ≤ Background Concentrations
EPA Region V - Ecological Screening Levels (ESLs) or something else?
No additional assessment/action needed
Location tracked in DNR database

Additional Consideration/Assessment Needed
Additional evaluation criteria (to be considered):
Total Organic Carbon (TOC)
Equilibrium Partitioning Sediment Benchmarks (ESBs)
Background concentration
Depth of contamination
Receptors
Waterway/waterbody type (e.g. sensitive environment, exceptional waterway)
Waterway/waterbody use (e.g. drinking water source, federal navigation channel, turning basin)
Advisory area (e.g. fish consumption, area of concern)

> Default Numbers and > Background Concentrations
Use default sediment numbers
Pursue site specific sediment numbers
Additional assessment/action needed (follow NR 700 process)
Location tracked in DNR database

Draft - Sediment Evaluation Process

(October 24, 2016 Version)

Initial Sediment Evaluation Criteria (refer to subsequent pages for more detailed information)
Project Type
Causation ss. 292.11(3)
Historical Knowledge - Source & Surrounding Area
Contaminant
Data Evaluation
Exposure Pathways/Receptors
Waterway/Waterbody (past, present & future)
Environment
Background Sampling (as appropriate)

OHWM determination needed?

Criteria being developed by Subgroup 3.

≤ Default Numbers and ≤ Background Concentrations
EPA Region V - Ecological Screening Levels (ESLs) or something else?
No additional assessment/action needed
Location tracked in DNR database

Additional Consideration/Assessment Needed
Additional evaluation criteria (to be considered):
Total Organic Carbon (TOC)
Equilibrium Partitioning Sediment Benchmarks (ESBs)
Background concentration
Depth of contamination
Receptors
Waterway/waterbody type (e.g. sensitive environment, exceptional waterway)
Waterway/waterbody use (e.g. drinking water source, federal navigation channel, turning basin)
Advisory area (e.g. fish consumption, area of concern)

> Default Numbers and > Background Concentrations
Use default sediment numbers
Pursue site specific sediment numbers
Additional assessment/action needed (follow NR 700 process)
Location tracked in DNR database

Draft - Initial Sediment Evaluation Criteria

(October 24, 2016 Version)

Legend
Blue Highlight = Initial Sediment Evaluation Criteria
Yellow Highlight = Additional Consideration/Assessment Needed (additional evaluation criteria to be considered)

Causation 292.11(3)

Project Type
Purpose of sampling effort
Define degree and extent (e.g. NR 700, known source/responsible party)
Deal with project area only (e.g. Chapter 30, NR 347, DOT, emergency cleanup, unknown source/responsible party)
Part of an upland redevelopment project
Part of a waterfront redevelopment project

Historical Knowledge - Source & Surrounding Area
Property boundaries
Surrounding land use
Area of known, unknown or potential contamination
DNR database search (BRRTS & SWIMS)
Historical sample data
On-going investigation, remediation, etc…
How and when the contamination was discovered
Permits: active or expired
Point/non-point discharge sources (current and historical)
Potential for recontamination
Source control

Contaminant
Naturally occurring or anthropogenic
Contaminant of Concern (COC) or Contaminant of Potential Concern (COPC)
Presence of NAPL
Toxicity
Mobility
Solubility
Stability
Persistence
Degradation potential
Bioavailability
Bioaccumulation potential
Volume (if known)
Depth

Data Evaluation
Adequate number of samples collected/analyzed
Sample collection techniques
Composite/Discrete sample
Sample preparation
Parameters analyzed
Laboratory (name & certifications)
Laboratory method
Laboratory detection limits
Normalization of data (was it done, how was it done)
Partitioning Factors (TOC, ESB, AVS)
Specific conductivity
Redox potential (ORP)
What lines of evidence were used
Sample locations reflective of surrounding land use, land cover, watershed
Statistical analysis
Age of data
Grain size/percent fines
All appropriate media sampled: sediment, soil, surface water, pore water, groundwater, NAPL
Geospatial coordinates

Exposure Pathways/Receptors
Human
Ecological
Both
Endangered/threatened resources
Fish/wildlife consumption advisories

Waterway/Waterbody (Past, Present & Future)
Type: lake, bay, river, lagoon, wetland, etc…
Ownership: riparian, state, responsible party
Designated use: drinking water source, recreational, navigation channel, turning basin, recreational, fishery, dam, millpond, etc…
Authorized depth

Environment
Geology
Topography
Geographic features
Surface water drainage patterns
Groundwater flow patterns
Surface water/groundwater interaction
Sensitive (exceptional waterway, wetland)
Ebullition occurring
Sediment type (soft, semi-consolidated, till, benthic zone)
Deposition or transient
Land use
Bathymetry
Institutional controls

Background Samples (as appropriate)
Adequate number of samples collected/analyzed
Distance from source
Collected: upgradient, upland, upstream, upwind
Collected away from: roads, railways, outfalls, parking areas, etc…
Locations reflective of surrounding land use, land cover, watershed
Similar characteristics as contaminated site: particle size, depth, geology, biology, physical, lithology, etc…
Consistent sample collection techniques, preparation, parameters, lab method, detection limits, normalization, TOC, ESB, AVS
Normalization of data (was it done, how was it done)
Rationale for using datasets (e.g. government resource(s), Chicago river)
What lines of evidence were used

Guidance Outline

How and When to Conduct Sediment Investigations:
The Site Discovery, Investigation, and Remediation Process

Background

- How are contaminated sediments sites typically discovered?
    - Redevelopment/Proposed redevelopment projects (i.e. upland, waterfront, or both)
    - Chapter 30 dredging project (e.g. navigation, pier installation, boat slip expansion, etc…)
    - Spills Law reporting requirements
    - Complaints
    - Discovery by DNR (e.g. Water Quality Biologist, Warden, etc…)
    - Other?

- What initial (pre-discovery) process steps are used at sediment sites?
    - Property/Project specific considerations and discussions begin
        - Evaluation of project scope
        - Evaluation of perceived/known environmental concerns
        - Evaluation of project cost
        - Project types
            - Redevelopment/Proposed Redevelopment
            - Chapter 30
            - Voluntary Party Liability Exemption (VPLE)
    - Common Participants
        - Property owner
        - Developer
        - Municipality
        - Economic Development Corporations
        - DNR – integrated approach that can involve multiple programs
        - Other state and federal agencies
            - Department of Health Services (DHS)
            - Environmental Protection Agency (EPA)
            - Great Lakes National Program Office (GLNPO)
            - U.S. Army Corps of Engineers (USACE)
- Check-in Point: Consider reaching out to DNR to discuss property/project specifics
    - DNR – Remediation & Redevelopment Program and Office of Great Lakes
        - Waterfront Redevelopment/Green Team/Technical Assistance
        - NR 700 Process
    - DNR – Water Resources
        - Chapter 30 pre-application

Site Discovery

- Refer to draft discovery flowcharts (with Ch 30 and without Ch 30)
- Conduct sediment sampling (as appropriate)
    - Analytical data obtained through Chapter 30 pre-application/application permitting process
    - Phase I/Limited Phase II
- Report data to DNR for evaluation
    - Chapter 292.11, Wis. Stats.
        - Notification for Hazardous Substance Discharge, Form 4400-225
        - Hazardous Substance Spills Reporting Requirements, PUB-RR-558
        - Wisconsin Spill Reporting Requirements – Condensed Version, PUB-RR-560
    - Chapter 30
        - DNR – Water Resources
    - Phase I/Limited Phase II
        - DNR – Remediation & Redevelopment Program
- ≤ Default #s and ≤ background concentrations
    - No additional sediment assessment needed
        - Issue Chapter 30 permit
            - No action required (NAR)
            - List in DNR database (e.g. BRRTS)
            - General liability clarification (GLC) letter – optional
- > Default #s and > background concentrations
    - Sediment contaminant source identification and evaluation
        - Known or suspected sediment contaminant source
            - List in DNR database (e.g. BRRTS)
            - RP letter issued
                - Enter NR 700 process
                - 30 days to hire a consultant
                - 60 days to submit a site investigation work plan (SIWP)
            - RP letter previously issued
                - Continue with NR 700 process
        - Unknown sediment contaminant source
            - No additional sediment assessment needed
                - Issue Chapter 30 permit
                - List in DNR database (e.g. BRRTS)
                - NAR

Check-in point: Consider obtaining DNR approval of Phase I/Limited Phase II and SIWP

Site Investigation (SI)

- Investigate known contaminant sources
    - Define degree and extent of contamination in all applicable media (i.e. soil, groundwater, vapor, surface water, and sediment)
- Establish background concentrations (if applicable)
- Evaluate multiple lines of evidence
- Interpret data and provide conclusions

- Consider multiple lines of evidence
- Determine screening levels and/or remedial action levels (RALs)
- Determine acceptable continuing obligations

- Check-in: Consider meeting with DNR to confirm the SI is complete, to discuss/establish project goals/targets/endpoints, RALs, remedial action (RA) options, disposal options, and sediment/habitat restoration requirements.

SI Report (SIR), Evaluation of RA Options, and Remedy Selection

- Exposure routes (i.e. human health, ecological, or both)
- Evaluation of long-term vs. short-term risk reduction
- Timeframe to achieve remedial action objectives (RAOs)
- Disposal options
    - Landfill
    - Confined disposal facility (CDF)
    - Beneficial reuse (e.g. Cat Island)
    - NR 718 exemption
    - Low hazard exemption (LHE)
- Check-in Point: Consider meeting with DNR to confirm:
    - Selected RA is acceptable
    - Selected RAOs are acceptable
    - Selected disposal options are acceptable
    - Whether or not the project is a GLLA betterment project candidate

Evaluate Potential Funding Sources (not applicable at all sites)

- Project viability
- Project cost/benefit considerations
- Project schedule
- GLNPO/DNR support for project

Remedial Action Report (RAP)

- Summarize remedial activities
- Outline post remediation monitoring approach
- Check-in Point: Consider meeting with DNR to confirm RA activities met goals and that post remediation monitoring approach is acceptable.

Site Restoration/Redevelopment and Habitat Restoration (not required at all sites)

- Site-specific considerations

Post Remediation Monitoring

- Check-in Point: Consider meeting with DNR to confirm site is ready for closure review

Case Closure

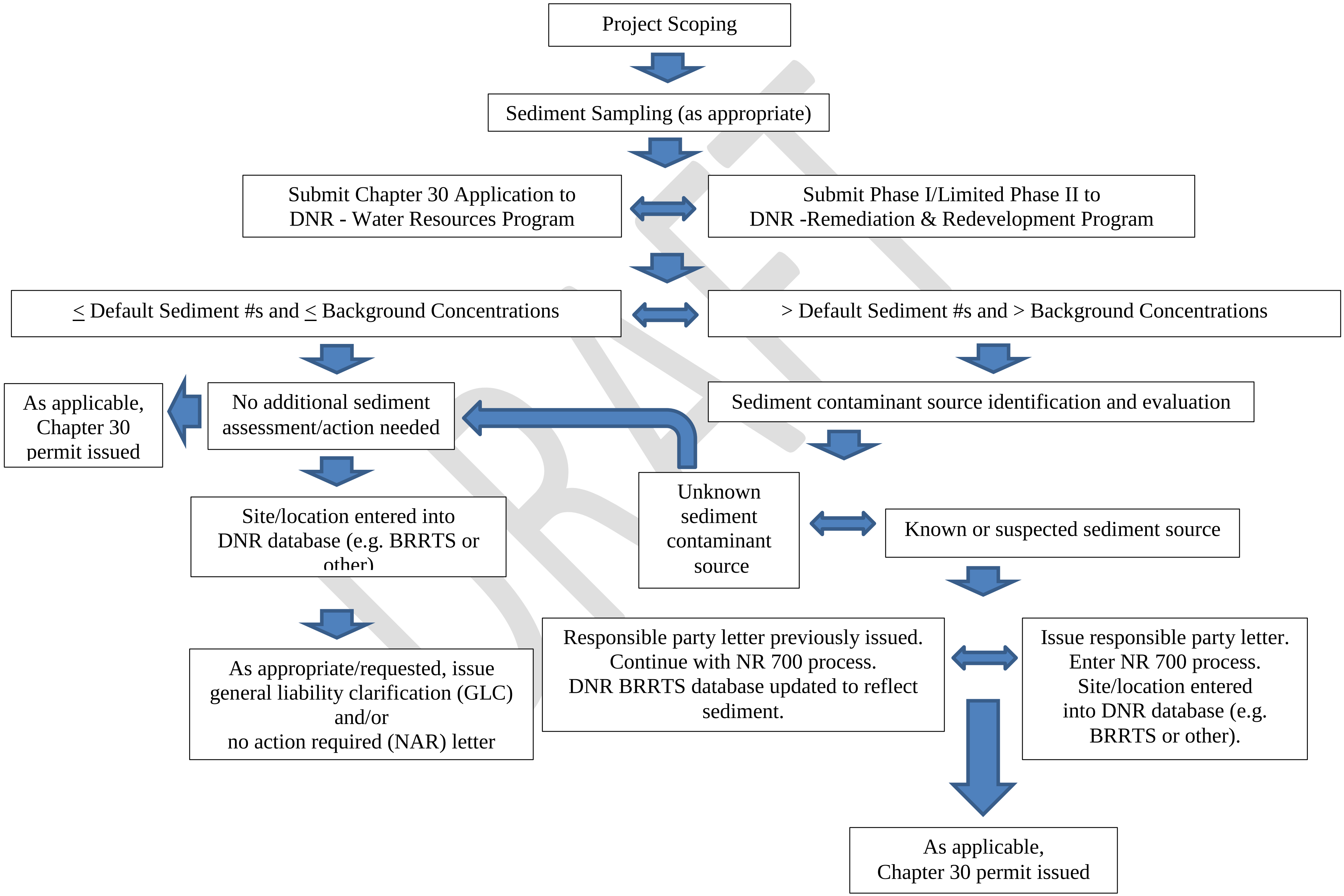
- Continuing obligations and long-term monitoring requirements (not required at all sites)

    - Sediment cover vs. engineering control
        - Financial assurance needed for engineering controls
    - Maintenance plans
    - Notification requirements (e.g. off-source, riparian, and USACE/USCG/LGU)
- Final closure letter
- Tracking of property/project continuing obligations in DNR database(s)

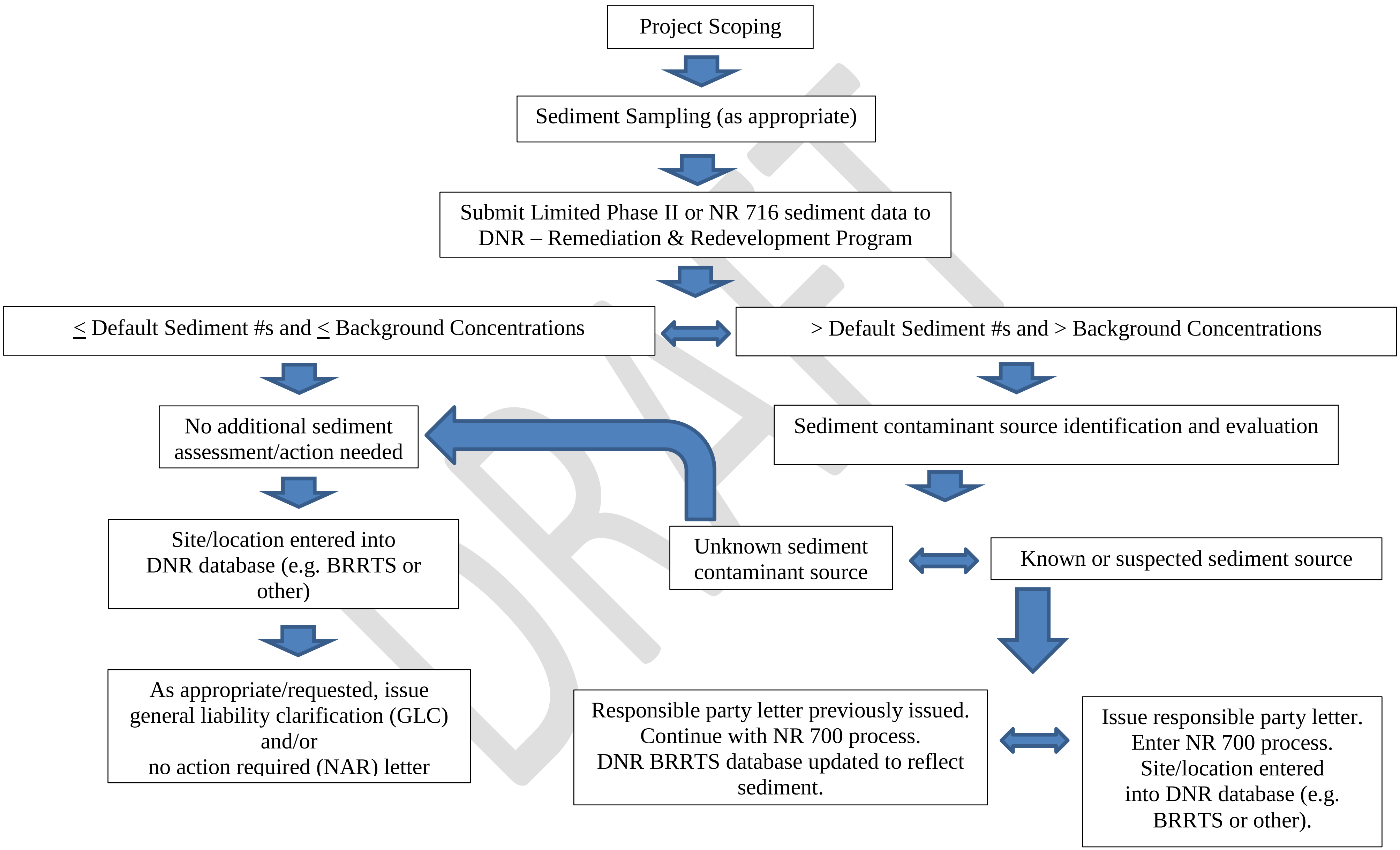
Post Closure Modifications
- Site-specific
- Agency notification
    - Chapter 30
    - NR 700 case closure requirements
- Modifications to sediment cover and engineering controls

As Applicable - Voluntary Party Liability Exemption (VPLE)

Discovery of Contaminated Sediment – with Ch 30



Discovery of Contaminated Sediment – without Ch 30



Resource List

Publication Name	Publication Number	Publication Date	Topic	Link	Comment
Evaluating Ecological Risk to Invertebrate Receptors from PAHs in Sediments at Hazardous Waste Sites (Burgess)	EPA/600/R-06/162F	October 2009	Sediment - tiered approach	PDF	October 6, 2016 Background Subgroup meeting
Chicago Background Study				PDF	October 6, 2016 Background Subgroup meeting
Manhattan Background Study					October 6, 2016 Background Subgroup meeting
ProUCL					October 6, 2016 Background Subgroup meeting
Contents of Site Investigation Reports for Petroleum Contaminated Sites	RR Pub # RR-628	October 2001	Contents of SI reports	PDF	
Analytical Detection Limit Guidance & Laboratory Guide for Determining Method Detection Limits, WDNR Laboratory Certification Program	PUBL-TS-056-96	April 1996	Detection limits	http://dnr.wi.gov/regulations/labcert/documents/guidance/-lodguide.pdf	
Compliance Averaging of Soil Contaminant Concentration Data under ch. NR 720, Wis. Adm. Code	DNR-RR-991	October 2015	Soil - averaging	http://dnr.wi.gov/files/PDF/pubs/rr/RR991.pdf	
Summary of DNR Response to Public Comments on RR Program Guidance	RR-991	December 3, 2015	Soil - averaging	http://dnr.wi.gov/news/input/documents/guidance/RR991Response.pdf	
Compliance Averaging of Soil Contaminant Concentrations	DNR	July 15, 2015	Soil - averaging	http://dnr.wi.gov/topic/Brownfields/documents/training/SoilAverageWebinar.pdf	
Contaminated Sediment Remediation Guidance for Hazardous Waste Sites	EPA-540-R-05-012	December 2005	Sediment - background, remediation guidance	https://sp.dnr.enterprise.wistate.us/org/AW/Team-RR/Integrated%20Sediments%20Team/Integrated%20Sediment%20Team/Reference%20Material/Contaminated%20Sediment%20Remediation%20Guidance%20for%20Hazardous%20Waste%20Sites%20-%20EPA%202005.pdf	
Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments	EPA-540-R-97-006	June 1997	Ecological risk assessment	https://sp.dnr.enterprise.wistate.us/org/AW/Team-RR/Integrated%20Sediments%20Team/Integrated%20Sediment%20Team/Reference%20Material/EPA_EcoRisk_1997.pdf	
Contaminated Sediments Remediation - Remedy Selection for Contaminated Sediments	ITRC	August 2014	Sediment - background, remedy selection	http://www.itrcweb.org/contseds_remedy-selection/Content/Resources/CSRPDF.pdf?_sm_au_=iSVTsHZWwSM3J755	
Smear Zone Contamination	RR-712	June 2013	NAPL	http://dnr.wi.gov/files/PDF/pubs/rr/RR712.pdf	
Case Closure with Residual Free Product - Can you get there from here?	PUB-RR-703	December 2002	NAPL	http://dnr.wi.gov/topic/Brownfields/documents/fees.pdf	
Assessment Guidance for Sites with Residual Weathered Product	PUB-RR-787	March 2014	NAPL	http://dnr.wi.gov/files/PDF/pubs/rr/RR787.pdf	
Guidance on Natural Attenuation for Petroleum Releases	RR-614	January 2014	NAPL	http://dnr.wi.gov/files/PDF/pubs/rr/RR614.pdf	

Publication Name	Publication Number	Publication Date	Topic	Link	Comment
Understanding Chlorinated Hydrocarbon Behavior in Groundwater	RR-699	October 2014	NAPL	http://dnr.wi.gov/files/pdf/pubs/rr/rr699.pdf	
Guidance for Environmental Background Analysis, Volume II: Sediment, NFESC User's Guide	UG-2054-ENV	April 2003	Sediment - background	https://clu-in.org/download/contaminantfocus/sediments/Final_Back%20Ground_Sediment_Guidance-Navy.pdf	
Guidance for Determining Soil Contaminant Background Levels at Remediation Sites	PUB-RR-721	December 2005, Revised October 2013	Soil - background	http://dnr.wi.gov/files/pdf/pubs/rr/rr721.pdf	
Remediation & Redevelopment Program, Issues and Trends 2016	DNR	August 2016	Soil - background	http://dnr.wi.gov/topic/Brownfields/documents/training/SoilContam20160803.pdf	
Wisconsin Statewide Soil-Arsenic Background Threshold Value	RR-940	July 2013	Soil - background	http://dnr.wi.gov/files/PDF/pubs/rr/RR940.pdf	
Role of Background in the CERCLA Cleanup Program	OSWER 9285.6-07P	April 26, 2002	Sediment - background	https://rais.ornl.gov/documents/bkgpol_jan01.pdf	
Guidance for Comparing Background and Chemical Concentrations in Soil for CERCLA Sites	EPA 540-R-01-003	September 2002	Soil - background	https://dec.alaska.gov/spar/csp/guidance_forms/docs/background.pdf	
Establishing Background Levels	EPA/540/F-94/030	September 1995	Soil - background	https://semspub.epa.gov/work/11/174005.pdf	
Soil Screening Guidance: Technical Background Document	EPA-540-R-95-128	May 1996	Soil - background	http://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=2&ved=0ahUKEwibk6bHyNXPAhUm24MKHanWDlgQFggiMAE&url=http%3A%2F%2Fhero.epa.gov%2Findex.cfm%2Freference%2Fdownload%2Freference_id%2F755533&usg=AFQjCNHCi9_pf_2VYu57Tg3pLEREFlfL6A	
Surface Water Quality Assessment of the Upper Illinois River Basin in Illinois, Indiana, and Wisconsin - Spatial Distribution of Geochemicals in the Fine Fraction of Streambed Sediment	USGS Open-File Report 87-473	1987	Previous WI background study	https://pubs.usgs.gov/of/1987/0473/report.pdf	
Background Sediment Chemical Concentrations, DNR - Bureau of Water Resources Management	DNR	1997	Sediment - background		
Recommendations for Trace Element Analysis of Natural Waters, Water Chemistry Program Water Science and Engineering Laboratory University of Wisconsin - Madison for WDNR	UW-Madison for DNR	1992	Sediment - background		
Contaminants in the Mississippi River 1987 - 92	USGS Circular 1133	1995 (?)	Sediment - background	http://pubs.usgs.gov/circ/1995/1133/report.pdf	
National Rivers and Streams Data	EPA	2014	Sediment - background	https://www.epa.gov/national-aquatic-resource-surveys/nrsa	Presented by Inman at September 19, 2016 meeting
Surface Water Information Management Information System (SWIMS)	DNR		Sediment - database	http://dnr.wi.gov/topic/surfacewater/swims/	
Navigation Dredging (potentially get from Corps)					

Publication Name	Publication Number	Publication Date	Topic	Link	Comment
Incorporating Bioavailability Considerations into the Evaluation of Contaminated Sediment Sites	ITRC	February 2011	Sediment - background	http://www.itrcweb.org/contseds-bioavailability/cs_1.pdf	
Incremental Sampling Methodology	ITRC	February 2012	Sampling	http://www.itrcweb.org/ism-1/pdfs/ISM-1_021512_Final.pdf	
The Risk Assessment Information System (RAIS)			EPA Region 5 ESLs	https://rais.ornl.gov/tools/eco_search.php	
Screening and Assessment of Contaminated Sediment, New York	NY State Department of Environmental Conservation	June 24, 2014	Sediment	http://www.dec.ny.gov/docs/fish_marine_pdf/screenasssedfin.pdf	
Contaminated Sediment Management Using Risk Assessment, WDNR Contaminated Sediment Work Group Meeting	NRT	February 8, 2016	Sediment	http://dnr.wi.gov/topic/Brownfields/documents/bsg/contamsedriskpres.pdf	Presented by NRT at February 8, 2016 meeting
Wisconsin's Surface Water Quality Criteria	DNR	March 30, 2016		http://dnr.wi.gov/topic/Brownfields/documents/bsg/waterqualitypres.pdf	Presented by Yang at March 30, 2016 meeting
Background/Ambient Studies Concentration Literature	EPA, NRT	March 6, 2013	Sediment - Chicago River Ambient Study		Presented at May 25, 2016 meeting
Consensus-Based Sediment Quality Guidelines, Recommendations for Use and Application, Interim Guidance	WT-732 2003	December 2003		http://dnr.wi.gov/topic/brownfields/documents/cbsqg_interim_final.pdf	
Soil Residual Contaminant Level Determination Using the U.S. EPA Regional Screening Level Web Calculator	PUB-RR-890	January 23, 2014	Soil - EPA calculator	http://dnr.wi.gov/files/pdf/pubs/rr/rr890.pdf	
2004 CBSQG Staff Training Manual Table				https://sp.dnr.enterprise.wistate.us/org/AW/Team-RR/Integrated%20Sediments%20Team/Contaminated%20Sediments%20External%20Advisory%20Group/CSEAG%20Work%20Group%20Meetings/2016-05-25%202004%20CBSQG%20Staff%20Training%20Manual%20Table.pdf	Presented at May 25, 2016 meeting
Incorporating Direct Measurements of Bioavailability into Sediment Polycyclic Aromatic Hydrocarbons Assessments at MGP Sites	EPRI	March 2012	Sediment - Background	PDF	Presented at July 25, 2016 meeting
Sediment Screening Values			Sediment - Background	PDF	Presented at July 25, 2016 meeting
Literature Review for Use of Background PAHs in Sediment	NRT Technical Memo # 2387-1	July 21, 2016	Sediment - Background	PDF	Presented at July 25, 2016 meeting
Literature Review for Published Sediment Screening Levels	NRT Technical Memo # 2387-2	July 21, 2016	Sediment - Background	PDF	Presented at July 25, 2016 meeting
Sediment Sampling and Analysis for Dredging Permit Application and Approval	Draft	Draft - May 2015	Sediment	http://dnr.wi.gov/news/input/documents/guidance/DredgingGuidance.pdf	

ORDINARY HIGH WATER MARK (OHWM)

Public waters subject to state public trust responsibilities are those lakes, ponds, flowages, rivers, streams and associated enlargements declared navigable under s. 30.10, Wis. Stats. These public waters are by the Wisconsin Constitution held in trust by the state for the benefit of all of its citizens.

The limits within which these water bodies are held in trust by the state extend from the open water, landward to the ordinary high water mark (OHWM). The OHWM is the point on the bank or shore up to which the presence and action of the water is so continuous as to leave a distinct mark either by erosion, destruction of terrestrial vegetation or other easily recognized characteristic. *Diana Shooting Club v. Husting* (1914), 156 Wis. 261, 272. The land between the waters edge and the OHWM **need not be navigable in fact** to be protected under the public trust. If the land is part of a navigable lake, then the fact that the specific area cannot be navigated is irrelevant to the state's claim. **Lakebed may be heavily vegetated by plants rising far above the water**. *State of Wisconsin v. Trudeau*, 139 W. 2d 91 (1987).

Ownership of the beds of public waters vary significantly, but state public trust responsibilities remain paramount regardless of bed ownership. The beds of all rivers and streams are owned by the adjacent riparian to the middle of the stream thread. The beds of all natural lakes are owned by the state up to the OHWM. Riparian owners of property adjacent to natural lakes, rivers and streams have exclusive use and some privileges of the exposed lakebed not otherwise afforded the public. Regardless of ownership, access to public waters must be gained legally. If the property surrounding a natural land locked lake were owned by one person then access to the lake could be achieved by obtaining the landowner's consent or in limited instances flying into the lake with a sea plane. Access to a public river or stream must be gained from the riparian owner or via another public access such as from a public boat landing or in many instances from a public highway that traverses the river or stream.

Considerations prior to making an OHWM Determination

1. The ultimate decision you make should, whenever possible, meet the "reasonable-prudent test". Could a prudent person come to the same conclusion as you. However, there will be situations where even the prudent person test will not apply (usually large rivers and lakes with high energy factors or where there are contiguous wetland complexes regardless of the size of the waterbody or energy factor.)

2. What kind of documentation will you rely upon to verify your determination? (Plants, water stains, wash marks, etc.) How can someone else verify the location of the OHWM? Will you take photos? Do you need a survey and benchmarks? How and where will you retain a record of your determination? What information should I have in the file that constitutes adequate documentation?

3. Can you defend your determination in court? OHWM determinations should be sufficiently documented with field observation notes, photographs, survey notes etc., to support your conclusions. Documented OHWM determinations can be included in the comments section of the Chapter 30/31 data base and a hard copy with your exhibits

should be filed in your water body files where you keep lake maps, surface water resource publications, water level records or similar archives that should be in your office. Another option is to place a copy of your documentation with the waterbody files that are maintained by fisheries management for fish surveys and the like. It is common to have physical and biological evidence of more than one OHWM, particularly on land locked lakes with no outlet, frequently flooded waterbodies and waterbodies with high energy forces. OHWM determinations should also be able to stand the test of time. A question you should always ask and answer yourself is have recent hydrologic events (major storms) created OHWM indicators that are not indicative of long term conditions (20 or more years).

4. Department liability. As a representative of the state, you make a decision that carries great weight. Not only in the sense of determining public and private rights and ownership, but your decision is also a potential liability to the state. Legislation allows one who is regulated to recover costs and damages for invalid determinations where the judicial system finds the state has erred (see s. 227.115, Stats.). In other words, mistakes can be costly.

5. Are you dealing with an altered body of water? Is it a flowage, perched lake or a stream with beaver problems? What has the average annual precipitation been in the past? What is it for the existing year? Are water levels too high (e.g., spring)? Is the waterway frozen (this can have a significant bearing on floating bogs)? All of these factors and more can have a bearing on your ultimate OHWM determination. What time of the year did you make your determination?

Water marks similar to OHWMs can be established in a short period of time. Rely upon OHWM indicators that reflect a long time period.
An ordinary high water mark that is indicative of the longest time period will <u>generally</u> be the easiest to defend.

The recommended procedure for determining an OHWM is to identify mature woody upland vegetation and work your way waterward. As you progress waterward you will find transitional plants (plants found above and below the OHWM) and aquatics (plants almost always found below the OHWM). Fine tuning of an OHWM can be accomplished with physical indicators. Those generally being wash marks, water stains and soil conditions (gleyed, mottled, redoxomorphic). These procedures should be repeated on the same water body at various locations to verify your original determination (multiple indicators work fine on ponds and lakes (with exception to very large water bodies). OHWM indicators on rivers and streams must take gradient into account as the OHWM changes in elevation with the gradient. Consistent multiple determinations will contribute to your credibility and ability to defend your final decision. Although you cannot use only water level records for the basis of your determination, this data can be used to support or validate your decision. The same holds true for historic photographs and other ancillary data.

<u>Multiple Ordinary High Watermarks</u> - "The Dilemma"

Occasionally you will find yourself in the situation of deciding which one of several distinguishable OHWM indicators are the right ones. The primary factor governing your decision should be which OHWM stands the test of time in combination with your confidence and ability to defend your determination. Secondary factors affecting your decision would include parameters generally associated with public interest values such as fishing, swimming, navigation, flora and fauna and associated habitat, etc. An OHWM that provides protection to these public values can be used in your defense of an OHWM determination. That is not to say that public interest values should dictate your decision, the criteria in Diana dictates your decision, however one can effectively argue public interest benefits associated with your determination versus a lower OHWM that does not include those public benefits.

Regardless of where your determination is finally selected, it is just as important for you to be able to explain why you didn't select the other OHWM indicators. This helps explain your scientific reasoning and will only add credibility to your final decision.

Problem Areas

As previously indicated, the prudent person test should be applied to OHWM determinations. However there are exceptions to the prudent person test. Generally, the prudent person test does not work for jurisdictional determinations where one is evaluating a pond/lake/deepwater marsh that may or may not have standing water present throughout the year. Another difficult determination is where you have either a river/stream/lake, particularly bog lake, with contiguous wetlands adjacent to the open water that can extend a great distance from open water to upland. Other situations where the prudent person test doesn't fit well is on waterbodies with extreme energy forces such as Lake's Michigan and Superior and the Mississippi, St. Croix, Chippewa and Wisconsin Rivers to name a few. We'll take a closer look at these potentially difficult situations.

Hydrology and Energy

The hydrology of waterbodies (ponds, lakes, deepwater marshes) can be driven by a variety of factors depending on whether or not the waterbody is a drainage lake, seepage lake, spring lake or drained lake. Drained lakes are those most likely to fall under this difficult category. That is primarily due to the facts that their hydrology is driven by precipitation, land use and evapotranspiration. These systems are frequently freeze-out lakes lacking a fishery, but have significant wildlife value including, but not limited to, waterfowl, shorebirds, amphibians and reptiles. These systems have major precipitation inputs during the spring and fall with an occasional input during the summer but have a tendency to become extremely shallow in late summer or sometimes even dry up during periods of drought.

When standing water is not present in a drained lake there should be areas within the dried lakebed that are lacking any vegetative cover surrounded by areas of persistent hydrophytes. The areas lacking vegetation are those that normally have standing water present throughout the growing season and are of sufficient depth to support the non-persistent aquatics such as coontail, bladderwort or pondweed. The observations combined with other historic information help one establish the basis that we are first dealing with a public waterbody.

The next step in determining the OHWM in these systems is to start at the upland and work your way waterward looking for observations such as the presence or absence of woody vegetation, wash marks, water stains, hummocks, adventitious roots, buttressing of woody plants and other characteristics normally employed in a OHWM determination. Once the OHWM is identified this elevation should be surveyed in to a permanent benchmark whenever possible. Then the elevation of the OHWM can be transferred around the perimeter of the waterbody for purposes of zoning setbacks or chapter 30 permit requirements when appropriate. Large water bodies having great energy factors will result in varying OHWM elevations and should be determined independently for each site along the shoreline where the energy forces vary.

Another problem area where the prudent person test generally does not work is when you're dealing with an aquatic system that has vast quantities of wetland complexes contiguous with the waterbody. This type of a system can occur with any aquatic environment but is usually prevalent with larger riverine complexes, flowages, and any of the lake types previously mentioned. The most common system exhibiting these characteristics are the bog lakes in northern Wisconsin.

The bog lakes and associated aquatic plant communities can expand vastly making an OHWM determination not only difficult but extremely time consuming. A few of the common problems associated with these systems are anchored and floating vegetative mats, substrate (mineral vs organic), and hydrology. Are the aquatic plant communities present because of the surface water in the bog or are the plant communities not associated with the lake but rather groundwater discharge or the water table. Many of the smaller bog lakes have floating vegetative mats around the perimeter of the open water where they abut upland or they have a perimeter of open water adjacent to the upland with a floating vegetative mat in the center of the lake. These bog lake systems are relatively easy to document the OHWM using conventional methods mentioned earlier. Other bog lakes aren't as easy to determine the OHWM relative to the wetlands contiguous with the lake. Under these circumstances, the use of surveying equipment, a soils probe or sharpshooter are essential tools that will help you pinpoint the location of the OHWM within or adjacent to the aquatic vegetative complex.

If you're fortunate enough to have an exposed shoreline lacking a bog complex in front of it, that will be the general location to select your OHWM. Certain circumstances will require you to locate the OHWM off site and transfer that elevation to the desired location with the use of surveying equipment (Remember transferring OHWM elevations from one site to another has been determined by the courts to be an acceptable method. *State v. McDonald Lumber Co.*, Inc., 18 Wis.2d 173 (1962)). This may be due to disturbances caused by man induced activities or the force of nature. Regardless select sites that are stable. Remember when transferring elevations avoid the use of the lake's surface water elevation as a turning point unless you know weather patterns are relatively stable and your survey will take a short period of time to accomplish (less than one hour). External forces can create a seiche (An oscillation of the water in a lake, bay, etc., caused by changes in barometric pressure, seismic disturbances, winds or waves, etc. Take the time to do a little more research into seiches, it's a fascinating subject.) that can alter the elevation of the lake surface within a relatively short period of time. Therefore using the lake surface water elevation as a survey turning point can induce elevation errors into your survey.

When transferring your OHWM elevation back into the bog complex, one should constantly be checking a few items in particular. The first is to determine if the bog is floating or anchored and then probe through the bog in search of terra firma, generally sand, densely compacted peat or muck. Take note of the distance between terra firma and the lowest point on the surface. When taking water levels within the bog, stand as far as possible away from the stadia rod to avoid false water level elevations that can be created by your weight while standing next to the rod. Surface elevation on the bog mat should be taken at the lowest level since the vegetative surface of the bog is undulating. Continue this process in a landward direction until you have come to the point where the elevation of terra firma and your OHWM elevation are relatively the same. This location would be the maximum lateral extent of the OHWM. Substantiate your determination with the vegetation (remember the standard in *Diana* that point up to which upland vegetation is destroyed). One reason why you are documenting terra firma is to ensure that the contour of the substrate is below the elevation of the OHWM. This will also help corroborate the hydrophytic vegetation present is associated with the lake and not groundwater.

Lastly let's venture into aquatic systems that really have a significant energy component associated with them. In particular we will address the great lakes of Superior and Michigan and large riverine systems such as the mighty Mississippi and any other riverine system that is utilized for hydropower.

We've mentioned seiches before and its potential affect on water levels. As previous mentioned seiches may be a result of a change in barometric pressure. For example a seiche in Green Bay caused by a significant change in barometric pressure can cause the water level to fluctuate by as much as two feet in a matter of hours. Seiches, specifically those associated with a change in barometric pressure may cause changes in surface water elevations but their relationship to the OHWM is extremely limited. Seiches associated with wind waves have a very strong relationship with the OHWM. Fetch, wind velocity and direction of wind are very critical components that determine where the presence of water is so continuous that it creates the OHWM. OHWM determinations for Lakes Superior and Michigan should be established along shorelines where there is some protection from high energy forces. For example, the ten year storm event can create what would appear to be the ordinary high water mark along the shoreline because there will be a very distinct wash mark and vegetation line. However the wash mark created by this storm event is a result of an event that may only happen once every ten years and is therefore not normal or ordinary. The stability of the shoreline will dictate where you make your determination. Avoid sandy shores where possible. In some locations the lack of upland vegetation is attributed to wind action and not wave action. Remember we're making a determination based upon what was created by the presence of water (wave action) on a fairly routine basis. Because of the energy forces associated with Lakes Superior and Michigan, these are probably the two most difficult waterbodies to determine an OHWM.

Large riverine systems such as the Mighty Mississippi and the St. Croix have several other energy components that influence the OHWM. Ordinary high water marks are generally established by the presence of water or wave action at an given elevation for a minimum of 30-70 (not necessarily consecutive) days a year, over a twenty year period. Keep in mind the Mississippi River is a controlled system, a series of locks and dams that are managed primarily for commercial navigation and flood control. Generally, during ice out in the spring through parts of June the water levels within each pool are normally held above flat control pool. These sustained periods of higher water levels combined with commercial and some recreational navigation have the greatest influence upon establishing the OHWM. The variability is directly attributed to management, use and position in the landscape. The pools lower in the system are first to thaw, first to be used for commercial navigation and play a more important role in flood control since they receive more water from the landscape. They will have a higher OHWM above flat control pool than pools located further upstream in the system.

Riverine systems utilized for hydropower are another rather unique ecosystem whose OHWM is primarily dictated by people management. Many of our large riverine systems were dammed in the earlier part of the 20th Century for the purpose of producing electricity. Those hydropower dams were operated as peaking systems whereby during the night water is held back in the flowage with very little flow being released and during the day when energy demands were higher substantial flows would be pass through turbines to generate electricity. This peaking operation would cause water level fluctuations in the flowage as well as the river downstream from the dam. The greatest fluctuation in level being the river downstream. These fluctuations would occur on a daily basis and thus the OHWM would then be determined by the highest flow passed on a regular basis as would the highest operating water level in the flowage. We've come a long way since the early 1900's and have in recent years began to understand the detrimental environmental impacts associated with a peaking operation. Most of our larger hydropower dams are no longer operated as a peaking system but rather as a run of river system (e.g. what goes in to the flowage goes out of the flowage). This flow regime mimics best would might occur under natural conditions. As a result, flows released through the dams are more uniform than a peaking operation and generally lower in flow and elevation. Therefore, riverine systems that are utilized for hydropower and that have since changed from a peaking to a run of river system will have remnants of an old OHWM higher than what the modern day OHWM currently is. The bottom line, do your homework, investigate the historical use of a riverine system and understand how that may or may not influence your OHWM determination. Always remember it is just as important for you to explain why you selected the OHWM indicators you did as well as those you didn't.

Using Vegetation Indicators

Plant species can often be very useful in determining your OHWM. Some species are almost exclusively found above or below the OHWM. However, many wetland species are capable of growing in either position. The main consideration when deciding whether to include vegetation as a major factor in your determination is whether the plant species or community is associated with a lake, pond or stream or whether the plants may be growing within a wetland unconnected to another surface water. The wetland may be contiguous and even discharging flow to a waterbody, but it may be elevated above the OHWM. Often, groundwater discharge wetlands which experience almost constant saturation may build organic matter above the OHWM of adjacent waterbodies. These wetlands may be located below the OHWM if they flood for a significant period of time.

The following list of plants are indicators that you can use in your OHWM determinations. As time progresses this list will expand. If you have additional species that you would recommend we add to the list, please share your information. Information about these and other Wisconsin vascular plant species can be found at the UW - Wisconsin State Herbarium web site at: http://wiscinfo.doit.wisc.edu/herbarium/.

Plants Generally Found Below the OHWM (Not inclusive)

If you are in an area adjacent to or connected to a lake or stream and aquatic plants are dominant, you are almost certain to be below the OHWM. Aquatic plants tolerate long periods of inundation, although they can survive short-period (1 week or less) dry-downs on an annual basis. Deep and shallow marshes may also be directly connected to lakes and streams. If you are in a wetland adjacent to a lake or stream and encounter the plants listed here or others which are designated as "obligate" wetland plants on the USFWS's "National List of Plant Species that Occur in Wetlands" (Indicator List), this area is generally below the OHWM. Listed below are the aquatic, semi-aquatic and marsh species you will commonly encounter in areas below the OHWM.

Aquatics

Armoracia lacustris	Lake cress
Callitriche spp.	Water starworts
Ceratophyllum demersum	Coontail
C. echinatum	Coontail
Chara spp.	Muskgrasses
Elatine minima, E. triandra	Waterwort
Elodea canadensis, E. nuttallii	Waterweed
Eriocaulon aquaticum	Pipewort
Isoetes spp.	Quillworts
Litorella uniflora	Plantain shoreweed
Lobelia dortmanna	Water lobelia
Megalodonta beckii	Water marigold
Myriophyllum spp.	Water milfoil
Nasturtium officianale	Watercress
Najas spp.	Slender naiad
Nitella spp.	Nitellas
Potomogeton spp.	Pondweeds[1]
Ranunculus aquatilis	Water crowfoot
R. flabellaris	Water crowfoot
R. gmelinii	Water crowfoot
Ruppia cirrhosa	Ditch-grass
Sparganium spp.	Bur-reed
Utricularia spp.	Bladderwort
Vallisneria americana	Wild celery
Zannichellia palustris	Horned pondweed
Zosterella dubia	Water stargrass

[1] *Potamogeton gramineus* may also occur on wet shores.

Floating-leaf Aquatic Plants

Brasenia schreberi	Watershield
Lemna spp.	Duckweeds
Nelumbo lutea	American lotus
Nuphar spp.	Yellow pond-lily
Nymphaea odorata	White water-lily
Polygonum amphibium	Water smartweed[2]
Riccia fluitans	Slender riccia
Spirodela polyrrhiza	Giant duckweed
Wolffia spp.	Watermeal

[2] *Polygonum amphibium* will also move out onto wet shores.

Marsh Species & Semi-Aquatics

Alisma spp.	Water-plantain
Dulichium arundinaceum	Three-way sedge
Eleocharis acicularis	Needle spikerush

Iris spp.	Iris species
Phragmites australis	Common reed grass
Pontederia cordata	Pickerel weed
Sagittaria latifolia	Arrowhead
Schoenoplectus acutus	Hard-stem bulrush
S. pungens	Three-square bulrush
S. tabernaemontani	Soft-stem bulrush
Sium suave	Water parsnip
Sparganium americanum	Bur-reed
S. eurycarpum	Bur-reed
Typha angustifolia	Narrow-leaved cattail
T. latifolia	Broad-leaved cattail
T. X glauca	Hybrid cattail
Zizania aquatica	Wild rice

Floodplain Forests and Hardwood Swamps

Streams may have floodplains which flood regularly enough to meet the criteria for areas below the OHWM. For an area to be considered below the OHWM, it must be inundated for a sufficient period of time (at least 30 days, not necessarily consecutive). Woody vegetation generally does not tolerate long-duration flooding without stress which may result ultimately in death. However, some species have adapted to tolerate saturated root zones for various lengths of time. For example, when silver maples (*Acer saccarinum*) are actively growing they may be able to tolerate seasonal flooding but its relative sugar maple (*Acer saccarrum*) cannot. Flooding often occurs in late winter or early spring when trees are still partially dormant. Flooding for shorter duration in the height of the growing season may not cause significant stress to the plants.

Old lacustrine basins may flood regularly and of sufficient duration to develop an OHWM. Hardwood swamps may develop in these basins and all or parts of these wetlands may be below the OHWM.

Use caution when using plants to determine the OHWM in floodplain forests and hardwood swamps. Aquatic plants are generally found below the OHWM, but many of the dominant species are trees, shrubs and forbes which are only seasonally inundated. These species can generally occur both above and below the OHWM. In these areas it is crucial that you either use documented hydrology data, erosion marks or other hydrology indicators to verify your OHWM determination.

Floodplain Forest and Hardwood Swamp Species

Acer rubra	Red maple
Acer saccarinum	Silver maple
Betula nigra	River birch
Carex spp.	Sedge species
Celtis occidentalis	Hackberry
Fraxinus nigra	Black ash
F. pennsylvanica	Green ash
Laportea canadensis	Wood nettle
Matteucia struthiopteris	Ostrich fern

Populus deltoides	Eastern cottonwood
Quercus bicolor	Swamp white oak
Rudbeckia laciniata	Cut-leaved coneflower
Salix nigra	Black willow
Ulmus americana	American elm

Other Transitional Areas

Open wetland areas adjacent to waterways may be marsh, wet meadow, sedge meadow, fen or open bog plant communities. As with floodplain forests, you need to use caution when determining the OHWM. Most important is determining if the wetland is directly connected to the waterway or if there is a significant difference in the source of the hydrology. For instance, some wetlands may be adjacent to lakes or streams but may be fed by groundwater discharge that is essentially separate from the water feeding the lake or stream. These wetlands are often substantially above the elevation of the waterway, and also above the OHWM. Make sure that the wetland area is influenced by the waterway's hydrology on a regular basis. Also, if the area is dominated by drier end wetland community types such as wet prairie or wet meadow, the plants are not likely to tolerate a lot of water on their roots. These plant communities endure short-duration saturation but will not survive if the saturation or inundation lasts well into the growing season. There may be exeptions if the inundation occurs early or late in the growing season. As with floodplain forests, document your OHWM determination with hydrology data and additional indicators.

Sedge (Cyperaceae) and rush (Juncaceae) families include species often encountered both above and below the OHWM. Common genera of the sedge family include *Carex* (sedge); *Eleocharis* (spike-rush); *Eriophorum* (cotton-grass); *Schoenoplectus, Bolboschoenus* and *Scirpus* (bulrushes) and *Cyperus* (nut sedge). Rushes (*Juncus*) are also often found both above and below the OHWM. These families are notorious for their difficult taxonomy. Although many of the sedges are obligate wetland plants, there are also many species of sedges found almost exclusively in uplands. Although it would be difficult to impossible to learn to identify all of the sedges, knowing some common species can be critical in making both OHWM and wetland determinations. There are no absolutes, but there are some general rules of thumb for sedges. For instance, lake sedge (*Carex lacustris*) and aquatic sedge (*C. aquatilis*) will often be found growing below the OHWM. Also, the bottlebrush-like sedges (*C. comosa, C. hystericina* and *C. pseudo-cyperus*), tend to grow below the OHWM when found adjacent to waterways.

Transitional species are often those plants you will find listed on the Indicator List as FACW (67% to 99% of the time growing in wetlands). This indicates that the species has adapted to wet conditions. These species are good indicators that water is present for a significant period of time. However, look for other indicators of long-term hydrology to substantiate your OHWM determination.

Fen Species (found both above & below the OHWM, not inclusive)

Aster firmus	Swamp aster
Bromus ciliatus	Fringed brome
Carex sterilis	Sterile sedge
Gentianopsis procera	Lesser fringed gentian

Lobelia kalmii	Kalms lobelia
Lycopus uniflorus	Northern bugleweed
Parnassia glauca	Grass-of-parnassus
Pedicularis lanceolata	Swamp lousewort
Pentaphylloides floribunda	Shrubby cinquefoil
Solidago ohioensis	Ohio goldenrod
S. riddellii	Riddell's goldenrod

Bog Species Found Both Above & Below the OHWM (not inclusive)

Andromeda glaucophylla	Bog rosemary
Betula pumila	Bog birch
Calla palustris	Water arum*
Carex oligosperma	Few-seeded sedge
C. pauciflora	Few-flowered sedge
C. magellanica	Boreal bog sedge
Chamaedaphne calyculata	Leatherleaf
Comarum palustre	Marsh cinquefoil
Cypripedium acaule	Moccasin flower
Drosera intermedia	Narrow-leaved sundew
D. rotundifolia	Round-leaved sundew
Eriophorum vaginatum subsp. *spissum*	Tussock cotton-grass
Eriophorum virginicum	Rusty cotton-grass
Gaultheria hispidula	Creeping wintergreen
Ilex mucronata	Mountain holly
Kalmia polifolia	Bog-laurel
Larix laricina	Tamarack
Ledum groenlandicum	Labrador-tea
Lycopus uniflorus	Northern bugleweed
Menyanthes trifoliata	Common buckbean
Sarracenia purpurea	Pitcher-plant
Sphagnum spp.	Sphagnum moss
Vaccinium angustifolium	Early low blueberry
Vaccinium macrocarpon	Large cranberry
Vaccinium myrtilloides	Velvet-leaf blueberry
Vaccinium oxycoccos	Small cranberry

Other Transitional Plants Found Above & Below the OHWM (not inclusive)

Acorus calamus	Sweet flag*
Alnus incana subsp. *rugosa*	Tag alder
Asclepias incarnata	Swamp milkweed*
Aster simplex	Lowland white aster
Aster umbellatus	Flattop aster
Calamagrostis canadensis	Bluejoint reedgrass
Calopogon tuberosus	Grass pink
Campanula aparinoides	Marsh bellflower
Carex muskingumensis	Muskingum sedge
Carex trisperma	Three-seeded sedge
Chamaedaphne calyculata	Leatherleaf

Chelone glabra	Turtlehead
Circuta maculata	Water hemlock
Equisetum spp.	Horsetail species
Eriophorum angustifolium	Cotton-grass
Eupatorium maculatum	Spotted joe-pye weed
Eupatorium perfoliatum	Boneset
Fraxinus nigra	Black ash
Galium boreale	Northern bedstraw
Glyceria striata	Fowl mannagrass
Iris virginica var. *shrevei*	Southern blue flag
Iris pseudacorus	Yellow iris
Impatiens capensis	Jewelweed*
Lathyrus palustris	Marsh pea
Leersia oryzoides	Cutgrass*
Lobelia siphilitica	Great Lobelia
Mentha arvensis	Wild mint
Phalaris arundinacea	Reed canary grass
Phragmites australis	Common reed grass
Pilea pumila	Clearweed
Polygonum punctatum	Smartweed
Salix spp.	Willow species
Solanum dulcamara	Purple nightshade
Solidago gigantea	Late goldenrod
Symplocarpus foetidus	Skunk cabbage
Urtica dioica	Stinging nettle
Viola cucullata	Marsh blue violet
Valeriana edulis	Valerian

*Most often located below the OHWM

Plants More Commonly Found Above the OHWM (not inclusive)

Abies balsamea	Balsam fir
Acer rubrum	Red maple
Apocynum androsaemifolium	Spreading Dogbane
Apocynum cannabinum	Indian Hemp
Asclepias syriaca	Common milkweed
Betula lutea	Yellow birch
Betula papyrifera	White birch
Calystegia sepium	Hedge birchweed
Cannabis sativa	Marijuana
Capsella bursa-pastoris	Shepherd's purse
Carya ovata	Shagbark hickory
Chenopodium album	Lamb's quarters
Cichorium intybus	Chicory
Cypripedium candidum	Small white ladyslipper
Daucus carota	Queen Anne's lace
Dryopteris cristata	Crested shieldfern
Erigeron annus	Daisy fleabone
Euthamia graminifolia	Grass-leaved goldenrod

Fragaria virginiana	Common strawberry
Fraxinum americana	White ash
Heracleum lanatum	Cow-parsnip
Hypericum perforatum	St. John's-wort
Juglans nigra	Black Walnut
Juniperus virginica	Red cedar
Oenothera biennis	Evening primrose
Oxalis stricta	Yellow wood sorrel
Parthenorissus quinquefolia	Virginia creeper
Picea glauca	White spruce
Pinus spp.	All species of pine
Plantago lanceolata	English plantain
Plantago major	Common plantain
Populus tremuloides	Quaking aspen
Prunella vulgaris	Heal-all
Pycnanthemum virginianum	Virginia basil
Quercus rubra	Red oak
Quercus alba	White oak
Ratibida pinnata	Prairie coneflower
Rhamnus cathartica	Common buckthorn
Rudbeckia hirta	Black-eyed susan
Setaria spp.	Foxtail grass species
Solidago altissima	Tall goldenrod
Rosa arkansana	Prairie rose
Rubus occidentalis	Black raspberry
Spartina pectinata	Prairie cordgrass
Spiraea tomentosa	Steeplebush
Taxus canadensis	Canada yew
Tilia americana	American basswood
Tradescantia ohiensis	Spiderwort
Tragopogon dubius	Yellow goatsbeard
Trifolium pratense	Red clover
Tsuga canadensis	Eastern hemlock
Verbascum thapsus	Common mullein
Viburnum lentago	Nannyberry
Vitis spp.	Grape species
Xanthium strumarium	Cocklebur

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